NASA TECHNICAL MEMORANDUM

NASA TM 78150

EFFECT OF SHELF AGING ON O-RING MATERIALS

By T. E. Wood and W. P. Stone
Materials and Processes Laboratory

January 1978

NASA

George C. Marshall Space Flight Center
Marshall Space Flight Center, Alabama

TECHNICAL REPORT STANDARD TITLE PAGE

1. REPORT NO. NASA TM 78150	2. GOVERNMENT ACCESSION NO.	3. RECIPIENT'S CATALOG NO.
4 TITLE AND SUBTITLE Effect of Shelf Aging on O-Ring Materials		5. REPORT DATE January 1978
		6. PERFORMING ORGANIZATION CODE
7. AUTHOR(S) T. E. Wood and W. P. Stone		8. PERFORMING ORGANIZATION REPORT #
9. PERFORMING ORGANIZATION NAME AND ADDRESS George C. Marshall Space Flight Center Marshall Space Flight Center, Alabama 35812		10. WORK UNIT NO.
		11. CONTRACT OR GRANT NO.
12. SPONSORING AGENCY NAME AND ADDRESS National Aeronautics and Space Administration Washington, D.C. 20546		13. TYPE OF REPORT & PERIOD COVERED Technical Memorandum
		14. SPONSORING AGENCY CODE
15. SUPPLEMENTARY NOTES Prepared by Materials and Processes Laboratory, Science and Engineering		

16. ABSTRACT

Commercial O-rings made from 13 different rubber compounds were tested for physical properties when they were received from the manufacturer and after 7 and 12 years of shelf aging. No gross changes were observed in tensile strength, elongation, or compression deflection characteristics.

17. KEY WORDS Commercial O-rings Shelf aging Tensile change Hardness change Compression change		18. DISTRIBUTION STATEMENT Unclassified — Unlimited	
19. SECURITY CLASSIF. (of this report) Unclassified	20. SECURITY CLASSIF. (of this page) Unclassified	21. NO. OF PAGES 21	22. PRICE NTIS

MSFC - Form 3292 (Rev December 1972)

For sale by National Technical Information Service, Springfield, Virginia 22151

LIST OF ILLUSTRATIONS

TECHNICAL MEMORANDUM 78150

EFFECT OF SHELF AGING ON O-RING MATERIALS

SUMMARY

The physical properties of 13 commercial O-ring compounds after 7 and 12 years of shelf aging were compared with the original properties. No gross property changes were detected. All O-rings tested are considered suitable for use after 12 years of shelf aging.

INTRODUCTION

The complexity, cost, and the possible disastrous consequence of the failure of any single component of a space vehicle have resulted in extreme reliability requirements for all components used in these vehicles. Because elastomeric materials are considered to be relatively perishable, much time and effort have been expended in developing specific, conclusive information on the effect of age on these materials. Described here are the results to date of one such effort.

EXPERIMENTAL

In 1962, 300 O-rings made from each of 13 different compounds in size 2-220 were purchased from Parker Seal Company for use in compatibility studies. All O-rings were individually packaged in sealed envelopes. All O-rings of a given compound were made from the same batch of mixed stock. All O-rings were cured in the fourth quarter of 1962. In the first quarter of 1963, 10 O-rings of each compound were randomly selected for test. The cross section of each O-ring was measured in 10 places around the circumference of the O-ring with the average of the 100 measurements made on O-rings from each compound being used as a standard dimension for all O-rings of that batch.

Tensile strength and elongation were measured on these O-rings for use as baseline data in future studies. The remaining O-rings were stored in their original packages in an internal store room. The temperature varied over the range of 15° to 32°C (60° to 90°F), depending upon the season.

In the third quarter of 1969 and 1974, 7 and 12 years after the original physical property measurements were made, 20 O-rings for each test period were randomly selected from each compound. Ten of these were used for tensile strength and elongation measurements. The remaining 10 were used for hardness and compression deflection measurements. These last two parameters were not measured in the original tests but were measured in 1969 and 1974. The tensile, elongation, and hardness data are shown in the Table. The compression deflection data are shown in Figures 1 through 13.

CONCLUSIONS

Based upon the results of this study and upon a visual examination of the O-rings tested, it is concluded that all the O-ring compounds tested are suitable for use after 12 years of shelf aging under the conditions described. Even though there are some changes in elongation with age, this property is of no real significance in O-rings, and applicable O-ring material specifications do not include elongation as a requirement. The differences in compression deflection characteristics are no greater than those normally found between different lots of O-rings made from the same compound.

TABLE. PHYSICAL PROPERTIES OF THIRTEEN O-RING COMPOUNDS

Compound Identity	Elastomer Type	Shore A Hardness			Tensile Strength								Elongation				
		Nominal	1969	1974	1963 (psi)	1969 (psi)	1974 (psi)	1963 (kg/cm^2)	1969 (kg/cm^2)	1974 (kg/cm^2)	Percent Change 1969	Percent Change 1974	1963 (%)	1969 (%)	1974 (%)	Percent Change from 1963 1969	Percent Change from 1963 1974
PSI-30-5	NBR	70 ± 5	80	80	1505	1585	1653	106	112	116	+ 5.3	+ 9.8	216	193	175	-10.6	-18.9
N304-7	NBR	70 ± 5	80	80	1648	1723	1772	116	121	125	+ 4.6	+ 7.5	178	168	160	- 5.6	-10.1
1011-10	NBR	60 ± 5	70	70	1487	1567	1631	105	110	115	+ 5.4	+ 8.8	351	289	285	-17.7	-18.5
47-071	NBR	70 ± 5	75	75	1460	1442	1471	103	102	104	- 1.2	+ 0.75	271	248	242	- 8.5	-10.7
109-7	NBR	70 ± 5	75	75	2610	2796	2588	184	197	182	+ 7.1	- 0.84	328	317	261	- 3.4	-20.4
B278-7	IIR	70 ± 5	80	80	1397	1463	1492	98	103	105	+ 4.7	+ 6.8	198	189	181	- 4.5	- 8.5
B318-7	IIR	70 ± 5	75	75	1503	1536	1601	106	108	113	+ 2.1	+ 6.5	247	234	225	- 5.3	- 8.9
C147-7	CR	70 ± 5	70	70	2193	2183	2144	155	154	151	- 0.5	- 2.2	303	245	229	-19.1	-24.4
S417-7	Si	70 ± 5	60	60	970	869	916	68	61	65	-10.4	- 5.5	255	210	233	-17.6	- 8.6
S451-7	Si	70 ± 5	75	75	1152	1091	1052	81	77	74	- 5.3	- 8.6	85	71	68	-16.5	-20.0
77-545	FPM	70 ± 5	75	75	1892	1694	1735	133	119	122	-10.4	- 8.2	173	165	172	- 4.6	- 0.5
V495-7	FPM	70 ± 5	75	75	1888	1783	1910	133	126	135	- 5.6	+ 1.1	182	175	180	- 3.8	- 1.0
V274-9	FPM	90 ± 5	90	85	1622	1680	1904	114	118	134	+ 3.5	+17.3	99	103	113	+ 3.8	+14.1

Notes: NBR — Nitrile-Butadiene Rubber
IIR — Isobutylene-Isoprene Rubber (Butyl)
CR — Chloroprene Rubber (Neoprene)
Si — Silicone Rubber
FPM — Fluorocarbon Rubber (Viton or Fluorel)

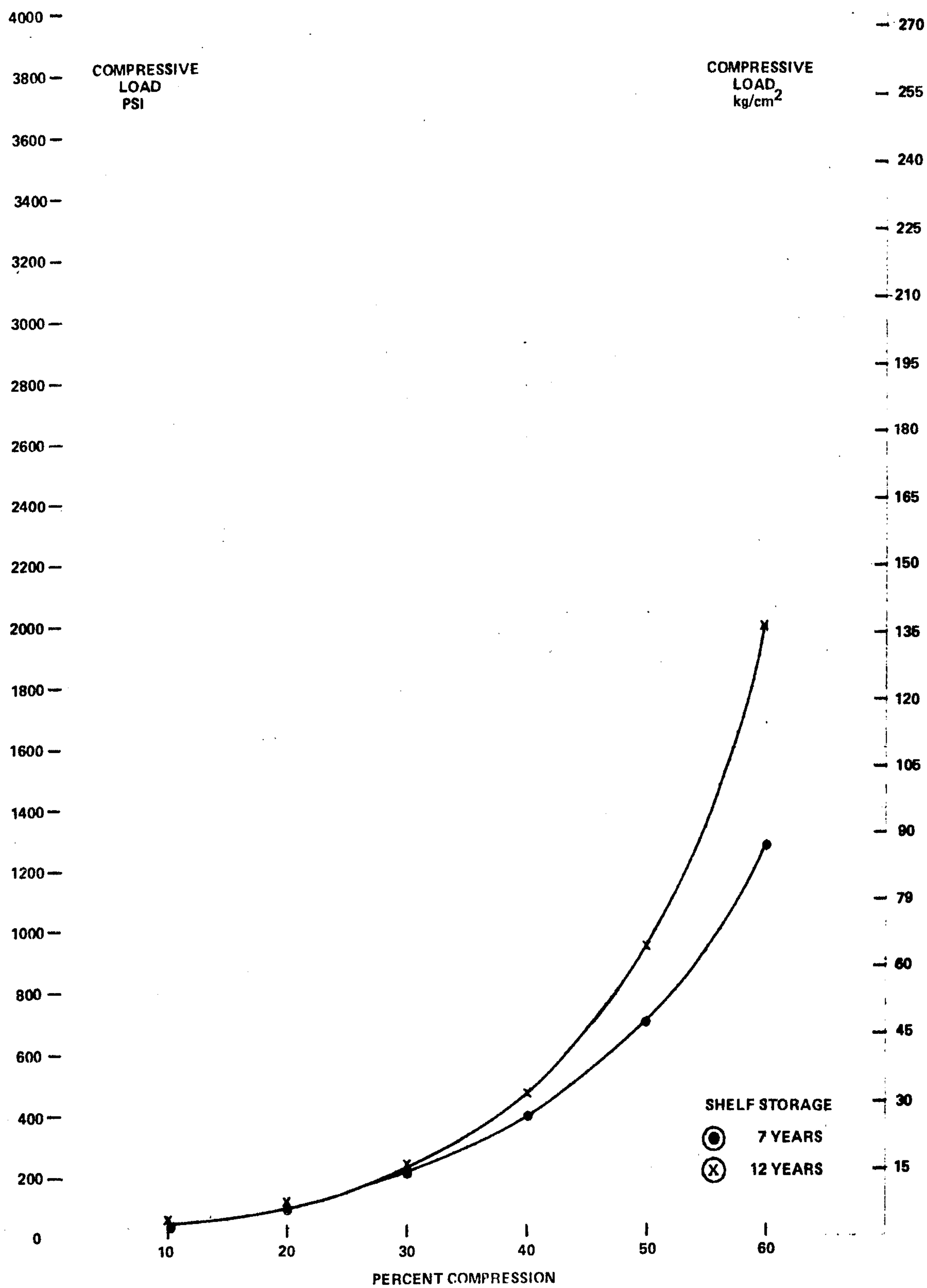

Figure 1. Buna-N PS-1-30-5.

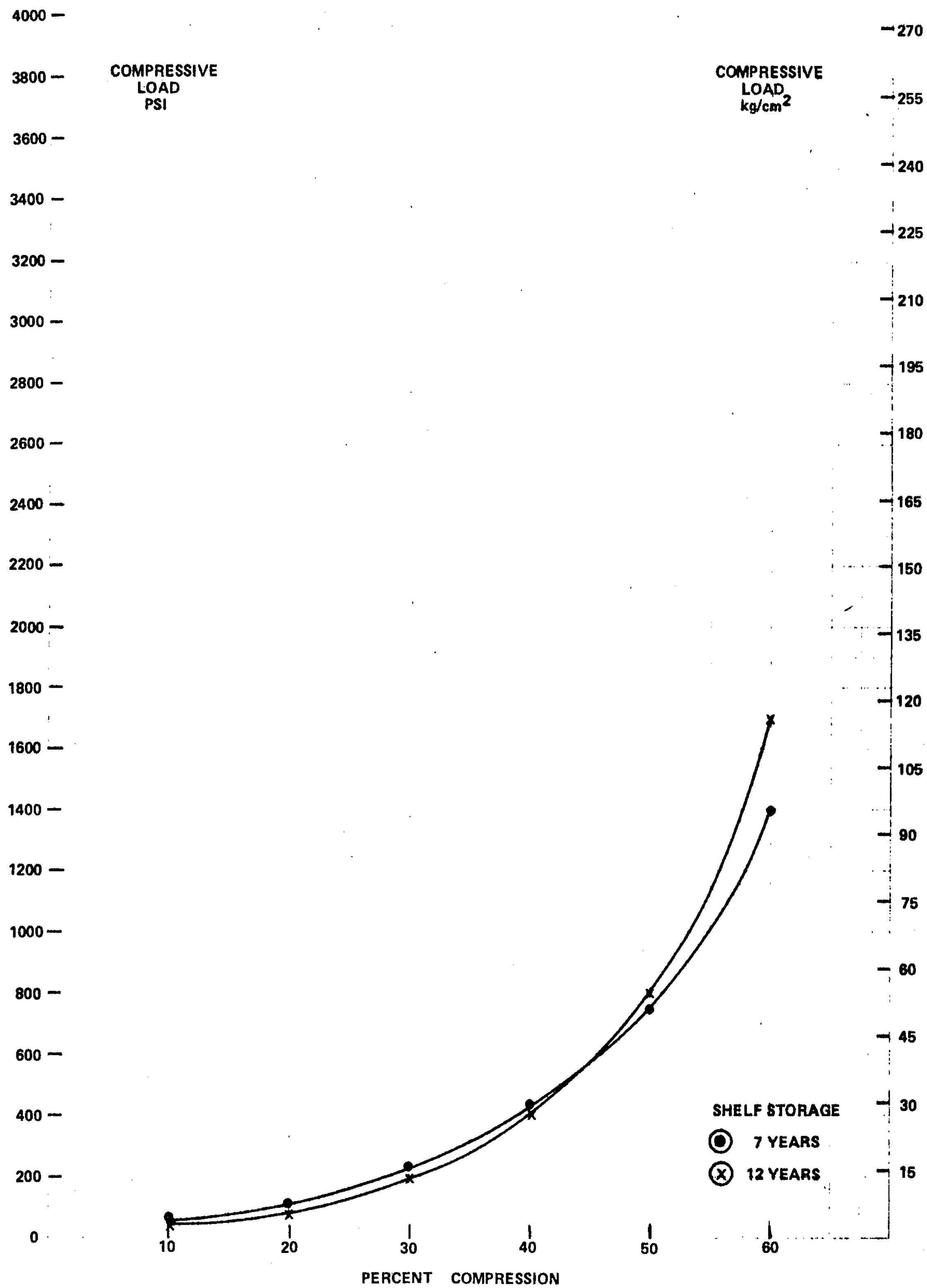

Figure 2. Buna-N N-304-7.

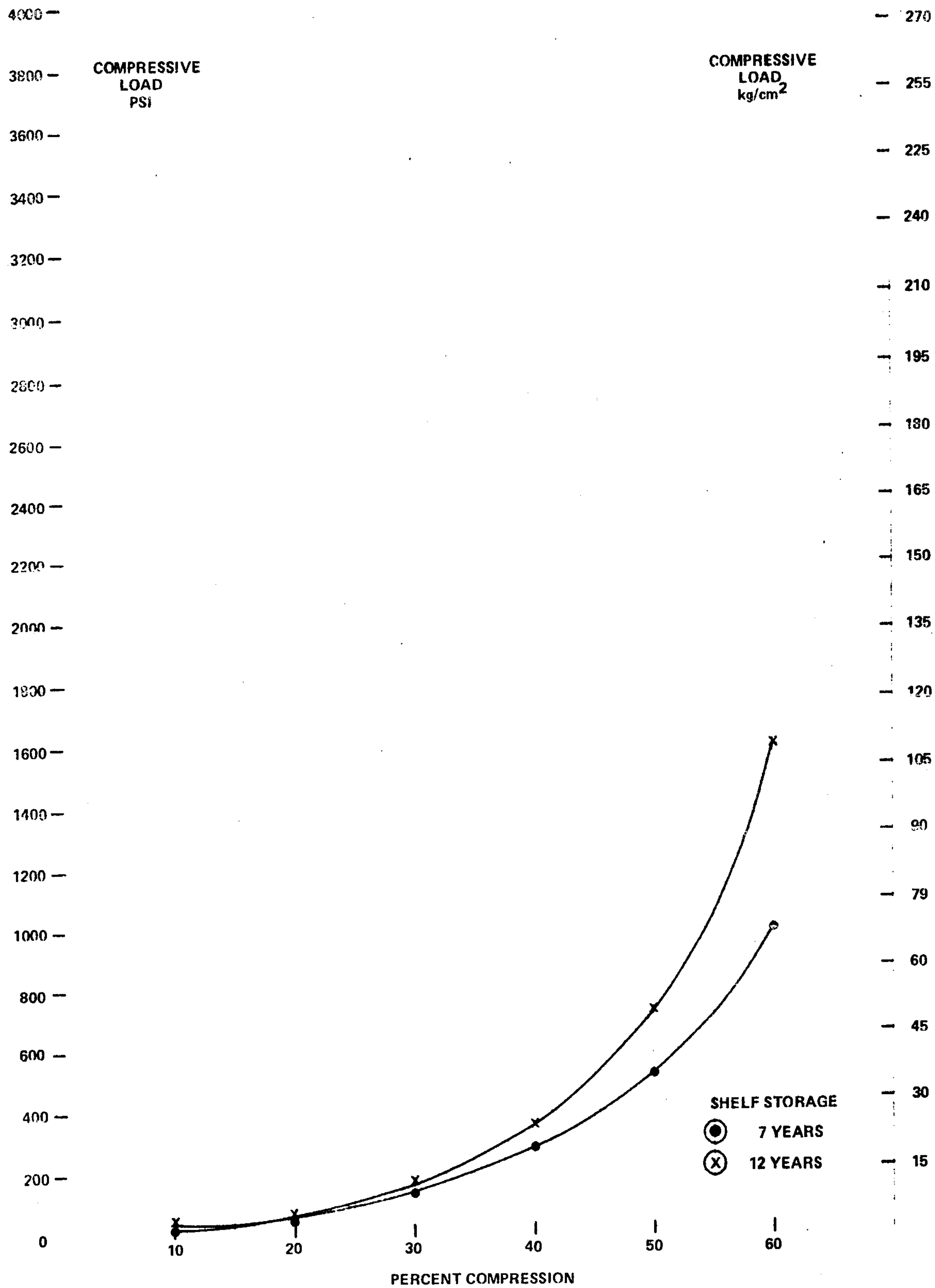

Figure 3. Buna-N 1011-10.

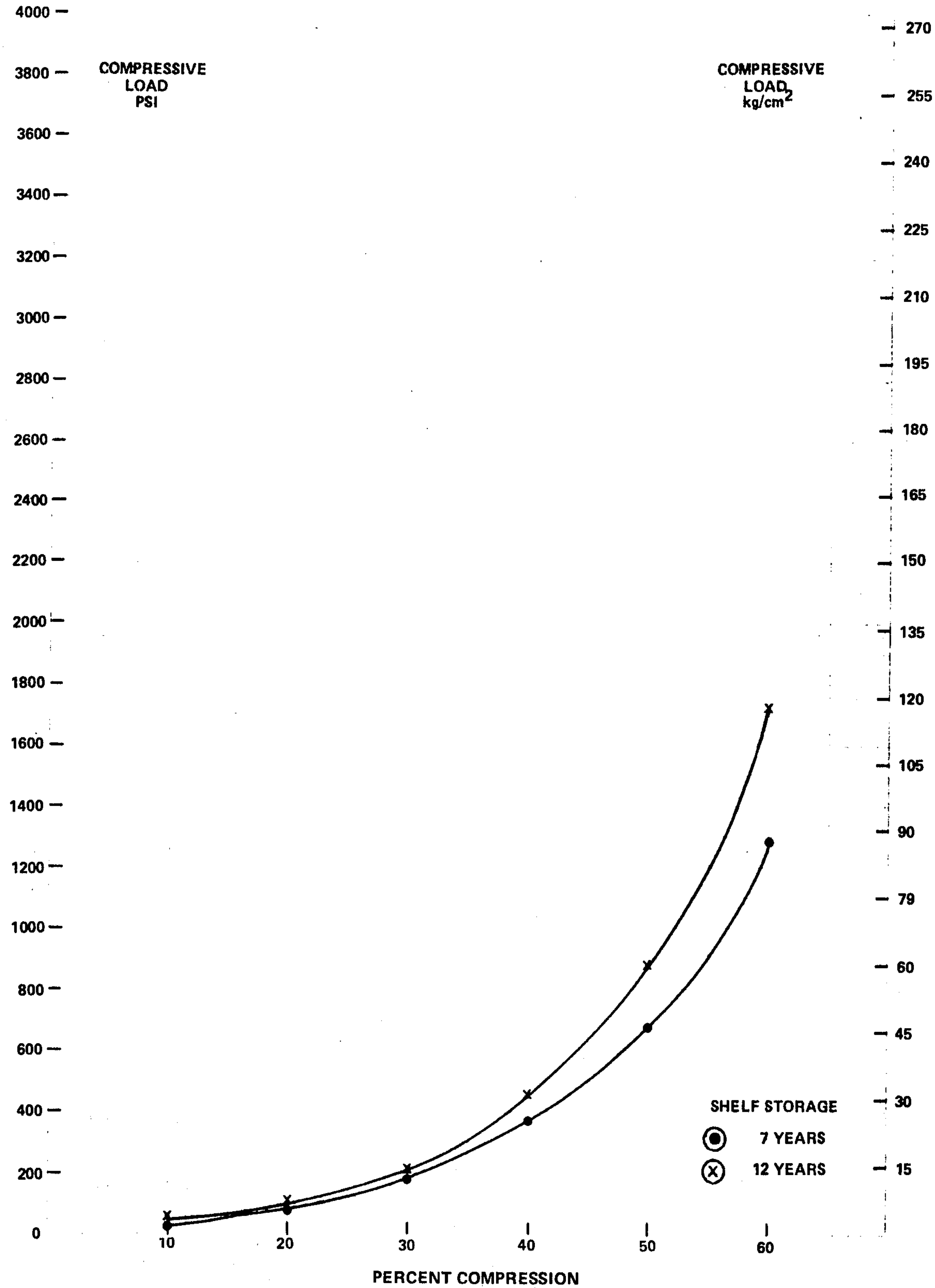

Figure 4. Buna-N 47-071.

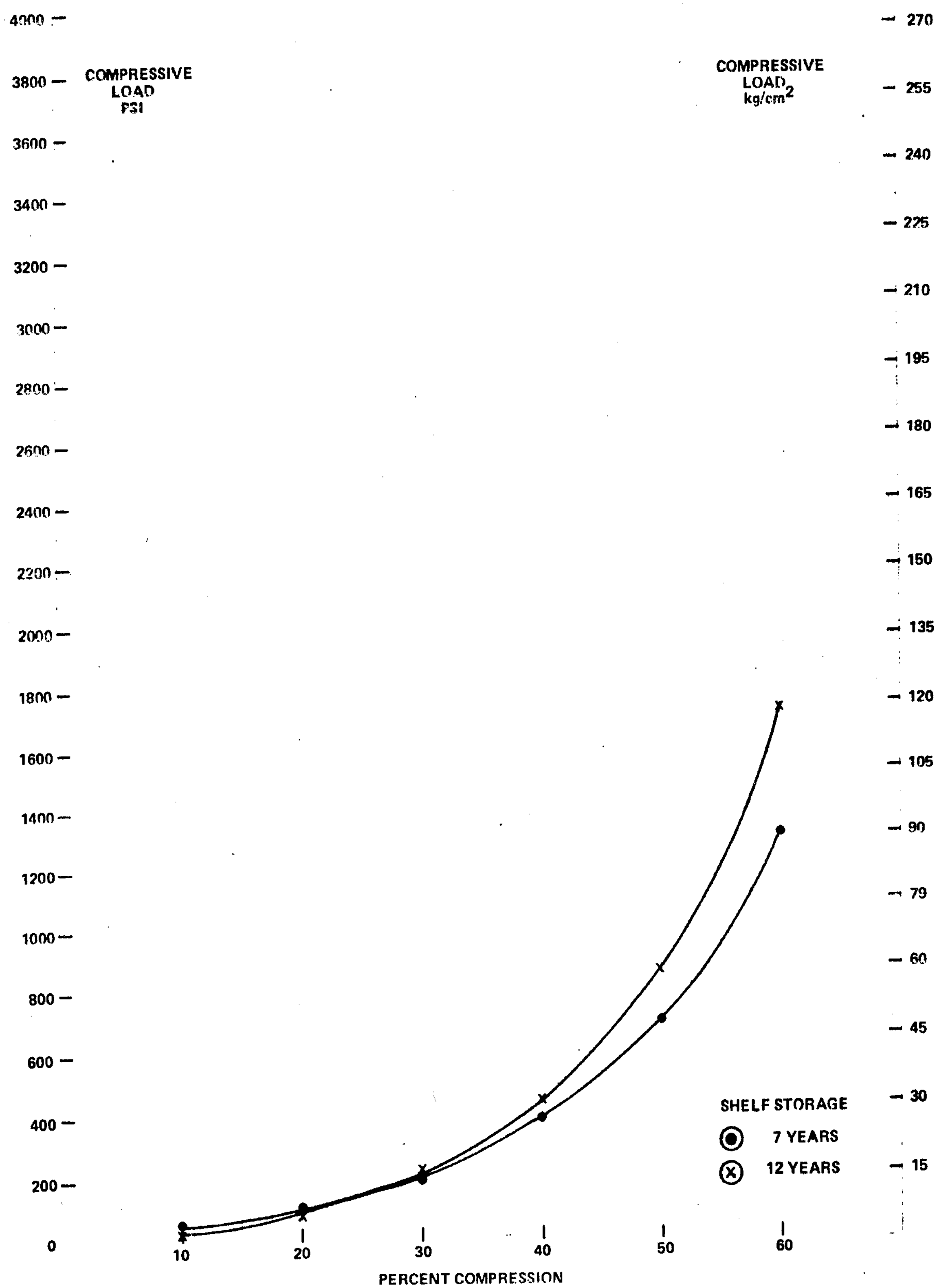

Figure 5. Buna-N 109-7.

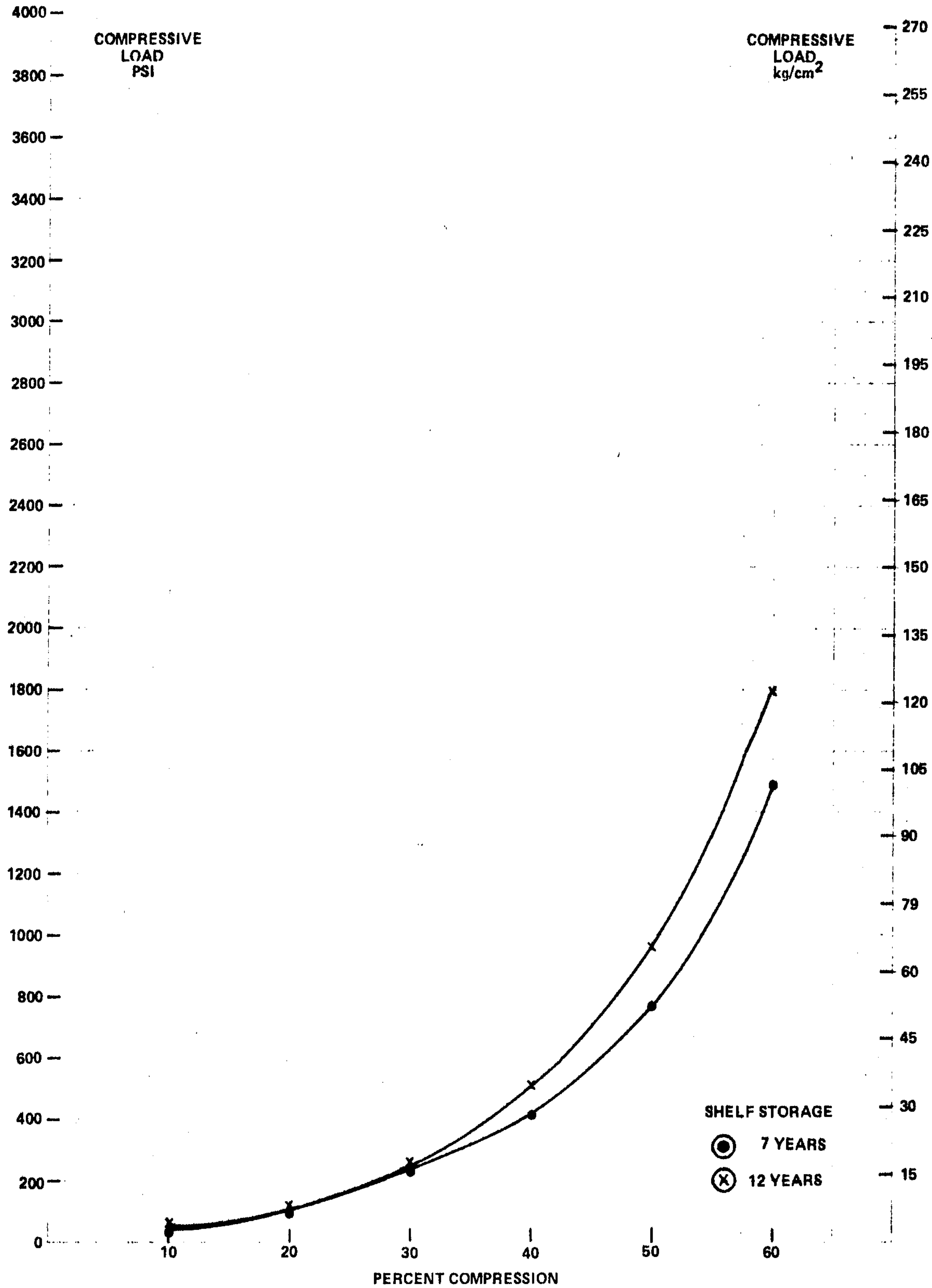

Figure 6. Butyl B-278-7.

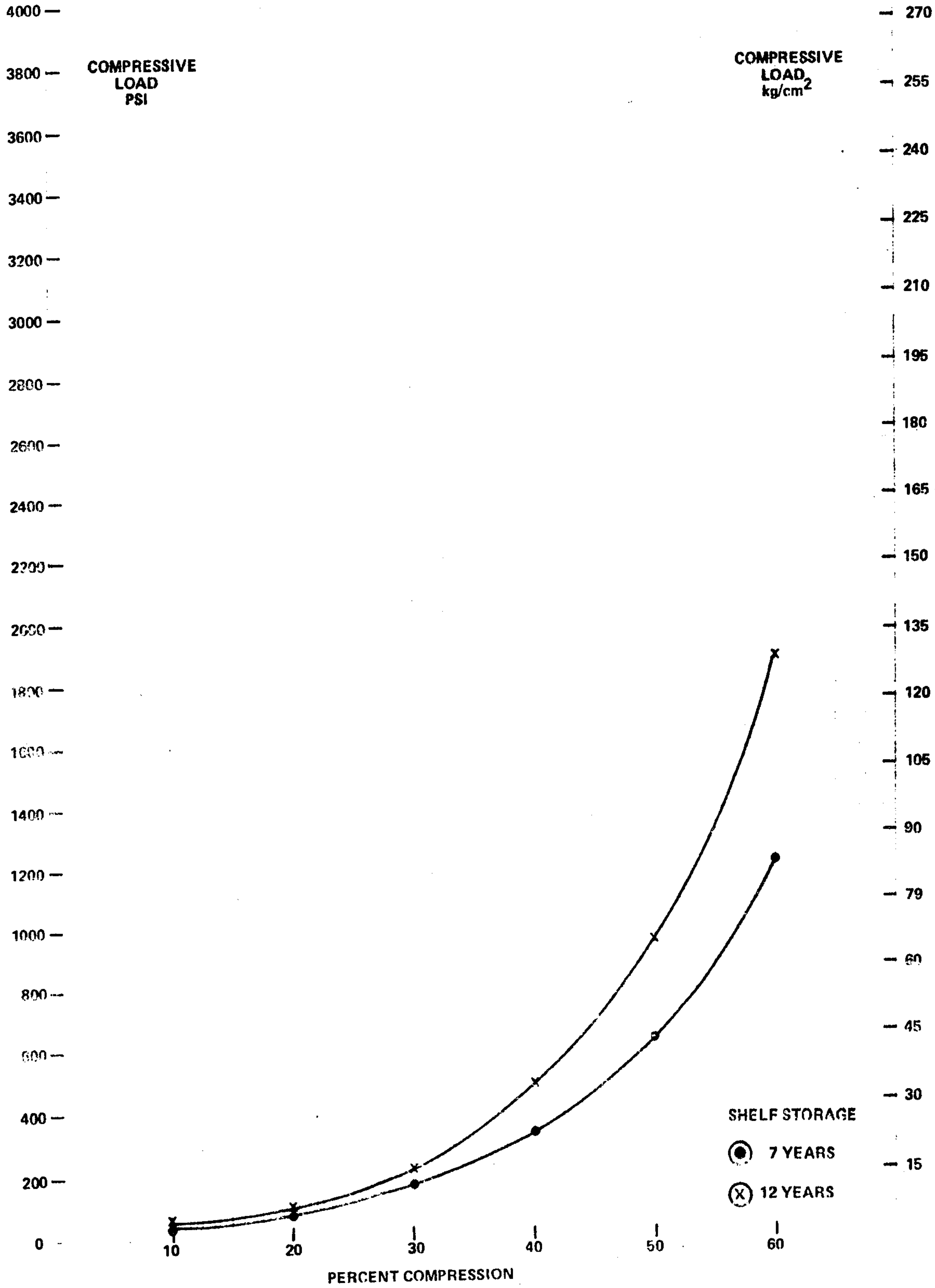

Figure 7. Butyl B-318-7.

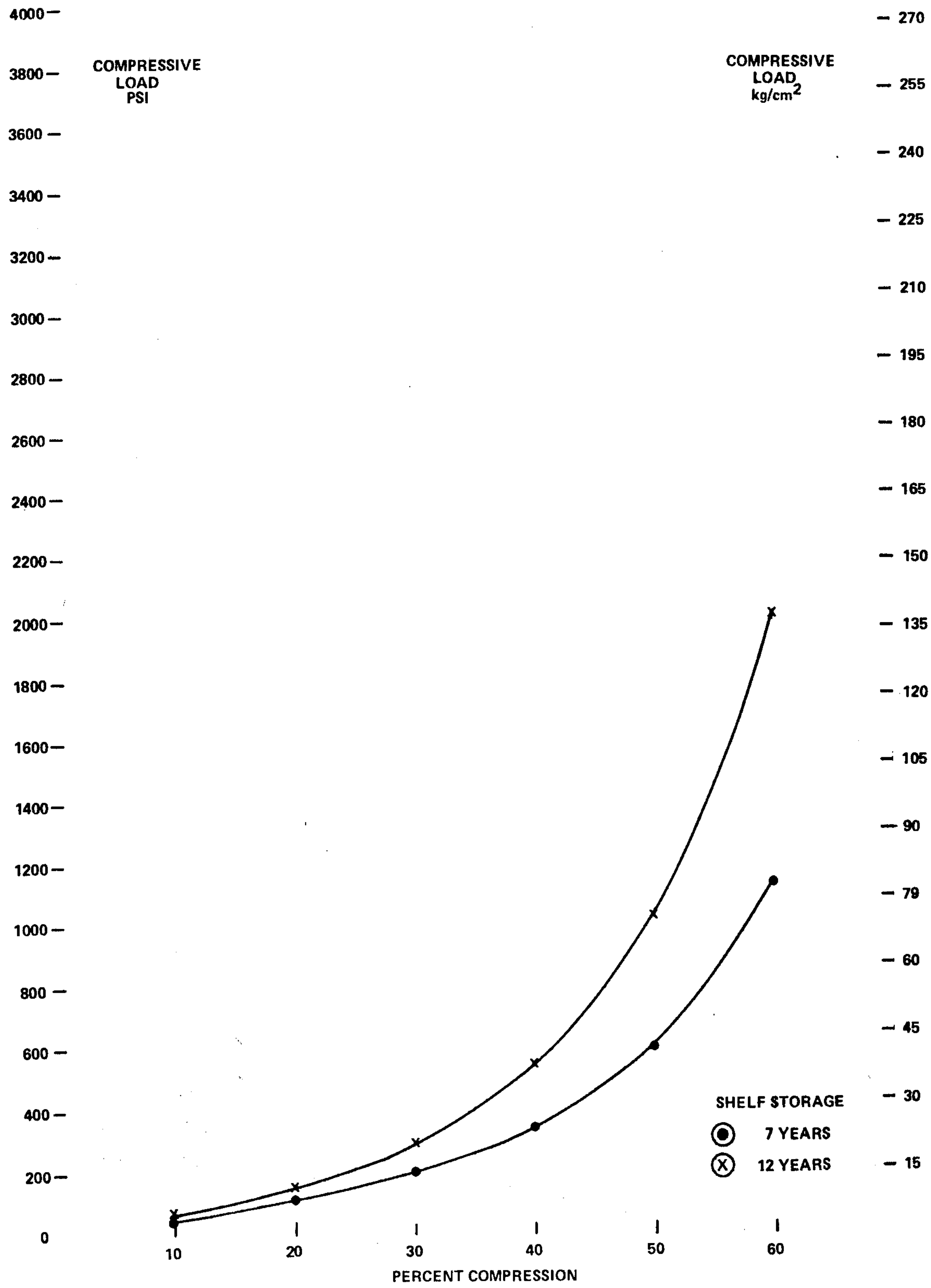

Figure 8. Neoprene C-147-7.

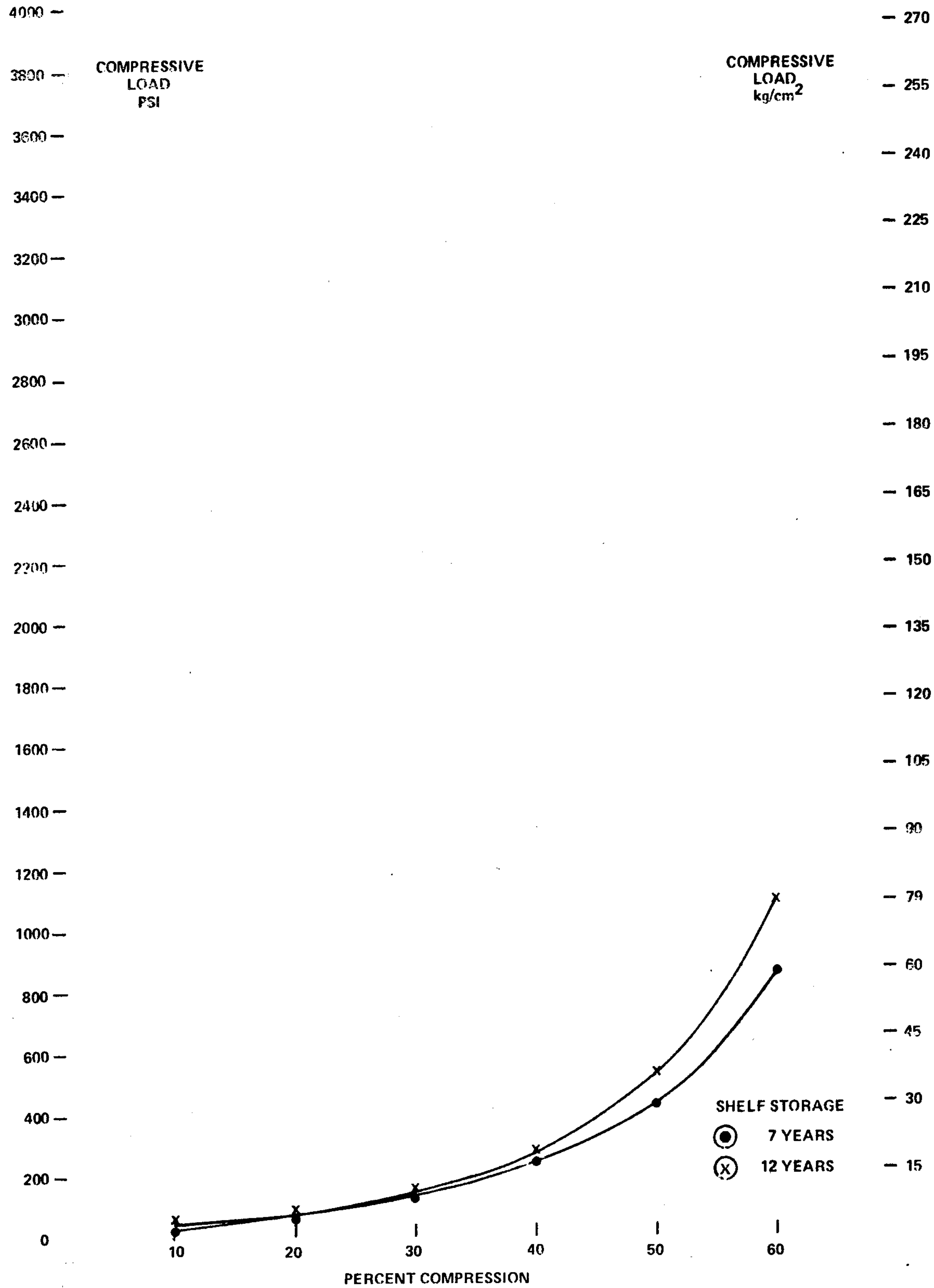

Figure 9. Silicone S-417-7.

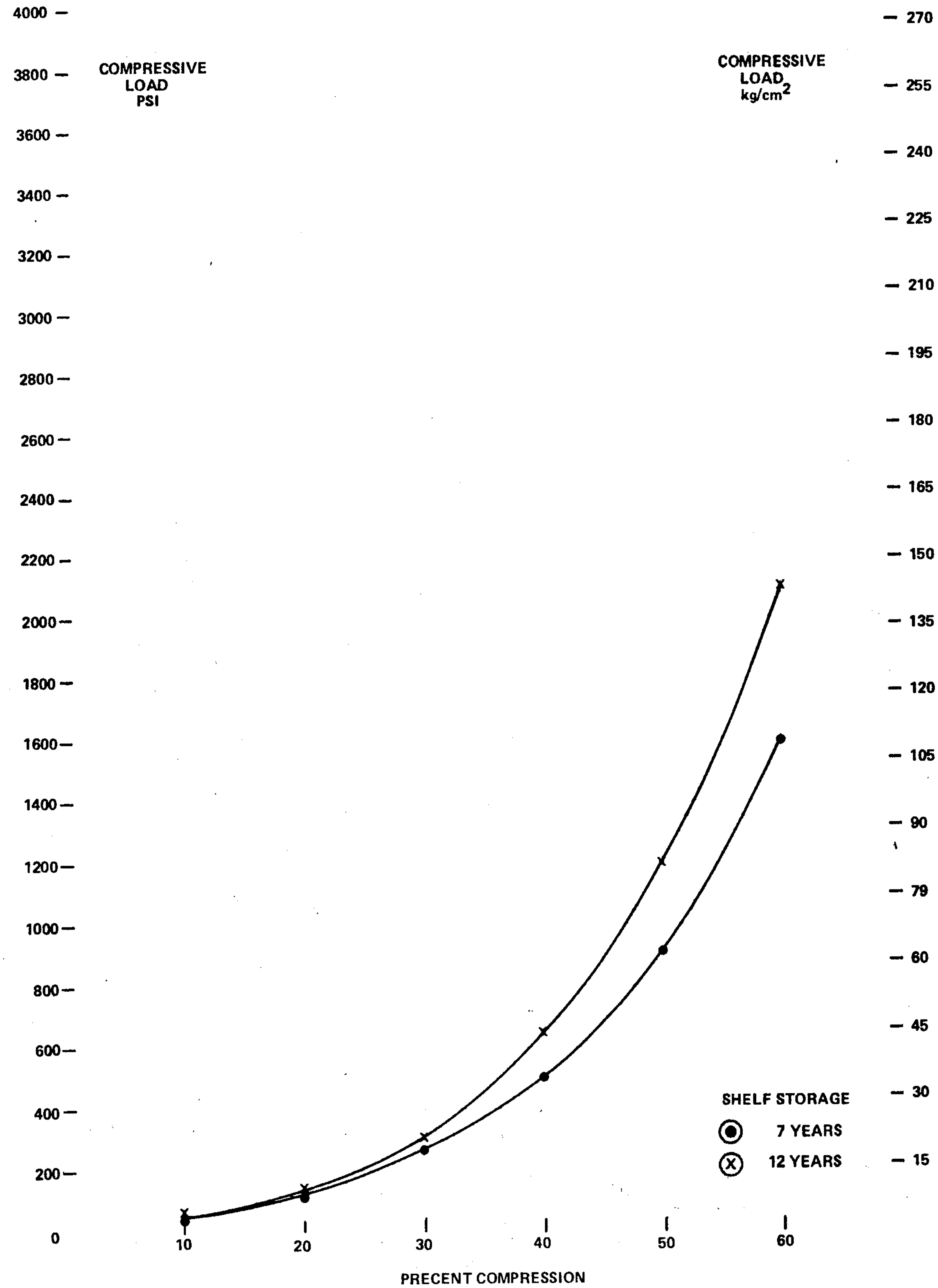

Figure 10. Silicone S-451-7.

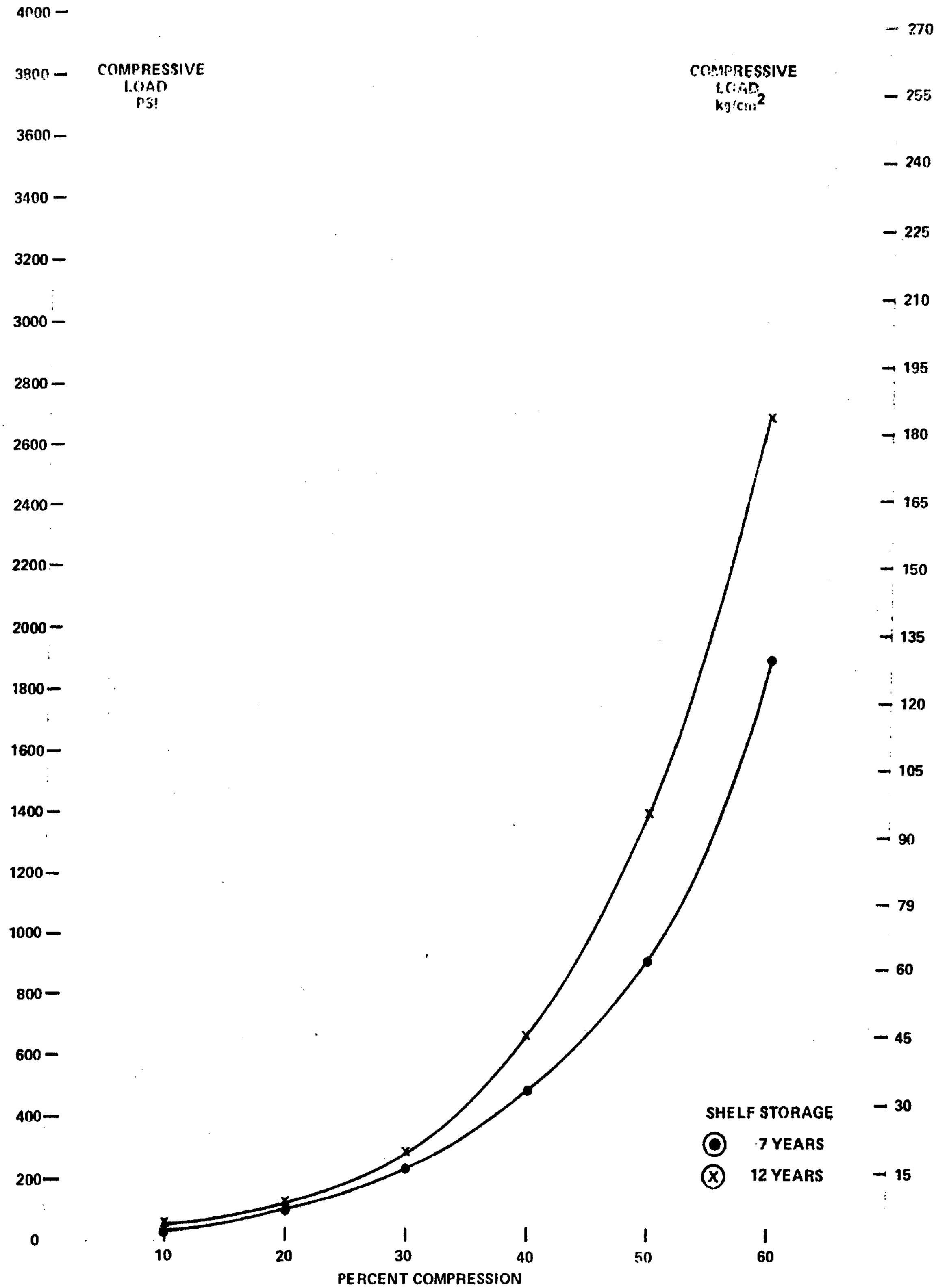

Figure 11. Viton 77-545.

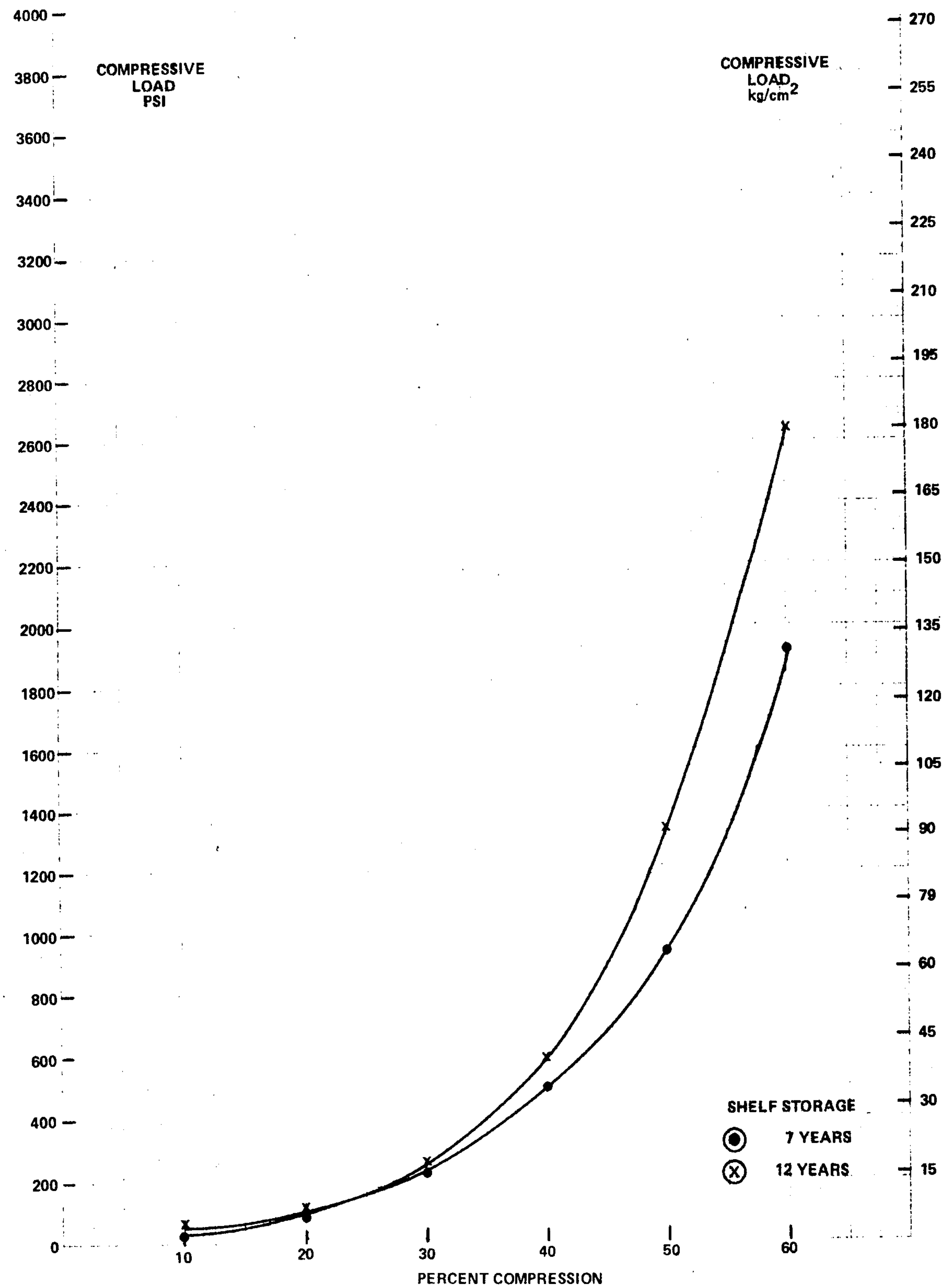

Figure 12. Viton V-495-7.

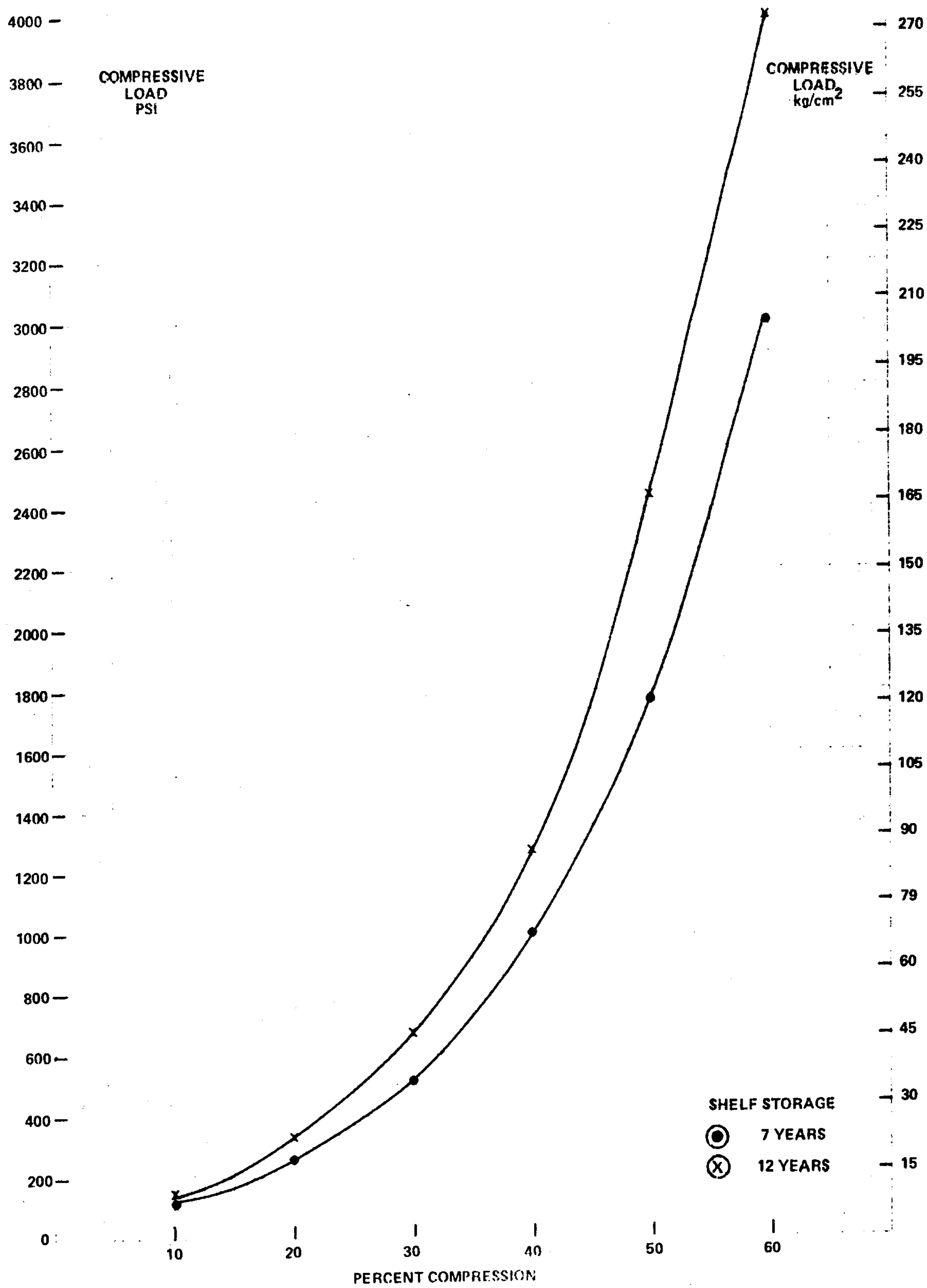

Figure 13. Viton V-274-9.

APPROVAL

EFFECT OF SHELF AGING ON O-RING MATERIALS

By T. E. Wood and W. P. Stone

The information in this report has been reviewed for security classification. Review of any information concerning Department of Defense or nuclear energy programs or activities has been made by the MSFC Security Classification Officer. This report, in its entirety, has been determined to be unclassified.

J. T. Schell
Chief, Polymers and Composites Branch

J. E. Curry
Chief, Non-Metallic Materials Division

R. J. Schwinghamer
Director
Materials and Processes Laboratory

☆ U.S. GOVERNMENT PRINTING OFFICE 1978—740-193/215 REGION NO. 4